SYSTEMS AND METHODS FOR RADIO FREQUENCY HEAD VALIDATION VIA ANTENNA COUPLING OR SIGNAL REFLECTION

BACKGROUND

[0001] The present disclosure relates generally to wireless communication systems and, more specifically, to testing radio functionality of a wireless communication device.

[0002] This section is intended to introduce the reader to various aspects of art that may be related to various aspects of the present disclosure, which are described and/or claimed below. This discussion is believed to be helpful in providing the reader with background information to facilitate a better understanding of the various aspects of the present disclosure. Accordingly, it should be understood that these statements are to be read in this light, and not as admissions of prior art.

[0003] Many radio frequency (RF) transceiver devices are programmed to communicate on a range of frequencies and may be tuned to communicate on a particular frequency band. In particular, the devices may be tuned to communicate on an underutilized frequency band to offload device usage from more congested frequency bands. For example, the millimeter wave (mmWave) frequency band, which ranges from 30 GHz to 300 GHz, may be an underutilized frequency band at a higher end of the radio spectrum. Fifth-generation (5G) cellular systems use the mmWave frequency band to offload data traffic.

[0004] However, communicating on the mmWave frequency band may result in high energy loss since the wavelength of the mmWave frequencies is small, making the mmWave band generally more susceptible to atmospheric and environmental interference in comparison to communicating using lower frequency bands (e.g., 1.8 GHz used for cellular signals, and 2.4 GHz or 5.0 GHz used for Wi-Fi signals). Various antennas and beamforming techniques may be used to overcome the high energy loss. In particular, beamforming techniques involve spatially directing wireless data transmission over multiple antennas for receiving and transmitting data, forming dense directional arrays to overcome transient signal degradation. Beamforming may also utilize a time division duplexing (TDD) communication scheme, which allows transmission and reception of signals during different time intervals for each of the device's antennas.

[0005] Often, dual-polarized antennas may be used to facilitate simultaneous transmission and reception of signals. Dual-polarized antennas allow transmitting signals from an antenna on a particular polarity and receiving signals at the antenna on an opposite polarity during the same time interval. Thus, a device operating using beamforming may be able to send and receive data during the same time interval, increasing throughput. However, due to any variety of reasons (including aging of components, extreme environmental factors, and the like), the device may not operate as intended. Due to the number of components (including the numerous antennas for beamforming) and software executing on the device, it may be difficult to determine the source of unintended operation.

SUMMARY

[0006] A summary of certain embodiments disclosed herein is set forth below. It should be understood that these aspects are presented merely to provide the reader with a brief summary of these certain embodiments and that these aspects are not intended to limit the scope of this disclosure. Indeed, this disclosure may encompass a variety of aspects that may not be set forth below.

[0007] The present disclosure generally relates to systems and devices for validating radio functionality of a wireless communication device. In general, validation may include antenna coupling validation and/or a reflector validation. Both the antenna coupling validation and the reflector validation may include a first set of steps that may be performed during manufacturing testing (e.g., testing conducted at the factory and prior to commercial use) and a second set of steps that may be performed during commercial testing (e.g., testing conducted by technical support during consumer use).

[0008] For example, an electronic device performing the antenna coupling validation may have multiple transmitters to transmit multiple signals and a receiver to receive a signal. Moreover, the electronic device may have a memory to store instructions and a processor to execute the instructions. During commercial testing, the instructions may cause the processor to send a test transmission signal from a transmitter of the multiple of transmitters, receive the test transmission signal at the receiver, and determine a gain of the test transmission signal. In response to determining that the gain is within a threshold range of an initial gain, the instructions may cause the processor to send an indication that the receiver is operating as expected.

[0009] The initial gain may be determined during the manufacturing testing. During manufacturing testing, the instructions may cause the processor to send multiple transmission signals from the multiple transmitters, receive the multiple transmission signals at the receiver, determine a strongest coupled transmission signal of the multiple transmission signals, and determine the initial gain of the strongest coupled transmission signal and the transmitter of the multiple transmitters.

[0010] Moreover, the electronic device performing the reflector validation during the manufacturing process may include instructions that cause the processor to send a second transmission signal from the transmitter of the multiple transmitters. The instructions may also cause the processor to receive the second transmission signal from the transmitter and reflected by a first reflector at the receiver, and the instructions may cause the processor to determine a second initial gain of the reflected transmission signal. During the commercial testing, the instructions may also cause the processor to send a second test transmission signal from the transmitter of the multiple transmitters, receive the second test transmission signal from the transmitter and reflected by a second reflector at the receiver, and determine the gain of the second test transmission signal. In response to determining that the gain is within a threshold range of the second initial gain, the instructions may cause the processor to send the indication that the receiver is operating as expected. As such, the antenna coupling validation and/or the reflector validation may be used to test radio functionality of the electronic device.

[0011] Various refinements of the features noted above may exist in relation to various aspects of the present disclosure. Further features may also be incorporated in these various aspects as well. These refinements and additional features may exist individually or in any combination.